

Global Underrepresentation of African Populations in Anatomical and Biomedical Datasets: Implications for Health Equity

¹Adeola Boluwatife ADENIJI, ²David Temidayo OVIOKE, ³Thomas Kehinde ADENOWO

¹adeolaboluwatifeadeniji@gmail.com/+2347059951107,

²ovioko.david@lcu.edu.ng/+2348142197434,

³adenowo.kehinde@lcu.edu.ng/+2348033539613

^{1, 2, 3}Lead City University

Abstract

Africa is a continent with a large population but with a reduced representation of Africans in anatomical and biomedical datasets globally. The accuracy and suitability of biomedical research is limited by this underrepresentation, perpetuating health outcome inequities. This study aimed to systematically review the extent to which there is an African underrepresentation in anatomical and biomedical datasets and its implications for health equity. The objectives are to analyze the extent of underrepresentation, identify the biomedical areas underrepresented, and to evaluate the clinical implications of overlooking anatomical variations. A systematic search was conducted using Google Scholar and PubMed, restricted to review articles published in the past five years. Out of 857 articles initially obtained from the search, 25 papers met the inclusion criteria, 14 papers from Google Scholar and 11 from PubMed. The limited number of acceptable studies itself show a systemic gap in the inclusion of African populations in biomedical research. This review highlights that the domination of Eurocentric datasets undermines accuracy in diagnosis, surgical safety, and therapeutic effectiveness in African contexts, especially in oncology, neuroimaging, and anatomy education. It underlines the necessity, both ethical and clinical, of incorporating African data into biomedical frameworks, while also identifying structural barriers such as weak research facilities and imbalance in funding. As a way forward, this review recommends that African-led research initiatives be prioritised, and deliberate expansion of anatomical and biomedical datasets, to reflect African population diversity be made.

Keywords: African population, underrepresentation, anatomical datasets, biomedical datasets

INTRODUCTION

Biomedical and anatomical datasets are pillars of present-day medicine, as they influence how diseases are studied, diagnosed, and treated. When these datasets lack diversity, the risk of bias exists in health innovations, which limits their applicability universally. Africa, with its many genetic and phenotypic variance, remains underrepresented in biomedical and anatomical research. (Mulder, 2021). Also, even though Africa has a large, genetically diverse population, most of the data used to study the human body and diseases comes from Europe and North America. This underrepresentation restricts the accuracy and applicability of biomedical

research and clinical practice, perpetuating health outcomes inequities. A study showed that only 3.9% of geoscience articles are on an African topic. In terms of academic impact, only 13 African authors were found out of 2744 total authors. There is also an intra-African imbalance in authorship as not all African countries are properly represented in biomedical and anatomical datasets. (North et al, 2020).

Africa is recognized as the cradle of humankind and harbors the greatest genetic variation among global populations (Feng, 2021). This diversity provides a unique opportunity to understand human biology, disease risk, and therapeutic responses more comprehensively (Pfennig, 2023). Yet, African populations remain disproportionately absent from biomedical studies, with most datasets historically dominated by Eurocentric cohorts (Mulder, 2021). Such exclusion undermines the relevance of biomedical models and perpetuates disparities in diagnosis and treatment (Sauer, 2022).

Evidence of underrepresentation is found across several domains of health research. In oncology, for example, the inclusion of African populations in cancer omics remains minimal, leaving significant gaps in knowledge that limit the application of findings to African patients (El Jaddaoui, 2020). Similarly, studies have shown that breast cancer survival outcomes across Africa remain poorly documented, with limited comprehensive datasets available for meaningful analysis (Badu-Peprah, 2025). In addition, genetic and epigenetic studies on cancer metastasis in people of African ancestry remain underreported, highlighting systemic inequities in oncology research (Oladipo, 2024).

The gap is also evident in clinical trials. Investigations into hepatitis B virus interventions have shown that the WHO African region remains underrepresented in clinical trial participation, despite the continent's high disease burden (Delphin, 2024). Comparable challenges are noted in neuro-oncology, where Africa contributes little to the global research output on primary brain tumors (Moawad, 2023). These deficiencies limit the development of precision medicine frameworks that could address context-specific health challenges on the continent (Marconi, 2025).

Cardiometabolic and neurological diseases illustrate further consequences of this imbalance. Research has emphasized that African ancestry populations have unique gene–environment interactions shaping cardiometabolic disorders, yet these populations remain understudied in biomedical data (Doumatey, 2023). Similarly, global studies on Alzheimer's disease continue to highlight significant gaps in diverse representation, leaving African populations outside the scope of emerging therapeutic advances (Reitz, 2023). This underrepresentation reduces the applicability of findings to African contexts and risks widening health disparities (Nuytemans, 2024).

At the same time, positive efforts are emerging. The Egypt Genome Project represents a landmark initiative that positions Africa within the global genomic landscape, marking a step toward closing the representation gap (Amer, 2024). Reviews of African genomic data argue that the continent's integration into biomedical research is central to driving global precision medicine (Ojewunmi, 2025). Studies on mitochondrial variation in tuberculosis susceptibility also underscore the scientific value of African diversity in advancing understanding of

infectious disease (Croock, 2025). Together, these examples illustrate both the opportunities and the urgent need for more inclusive data.

The review aimed to critically examine the underrepresentation of African populations in anatomical and biomedical datasets, highlighting how this gap constrains diagnostic accuracy, surgical safety, and therapeutic outcomes. Its objectives are to analyze the extent of underrepresentation, the biomedical areas underrepresented and to evaluate the clinical implications of overlooking anatomical variations.

This review is justified by the urgent necessity of addressing systemic inequities in biomedical research that continue to exclude African populations. By synthesizing evidence from oncology, cardiometabolic science, neuroscience, and genomics, it demonstrates how greater inclusion of African data is essential for health equity and for advancing biomedical knowledge globally.

METHODOLOGY

Search Strategy and Data Sources

A comprehensive literature search was conducted using Google Scholar and PubMed to identify relevant studies examining the underrepresentation of African populations in anatomical and biomedical datasets. The search was limited to publications from the last five years (2020–2025) in order to capture the most recent advances and discussions.

The keywords and Boolean operators employed included “*Global Underrepresentation*”, “*African Population*”, “*Anatomical and Biomedical Datasets*”, “*Health Equity*”, “*Africa*” OR “*datasets*” OR “*underrepresentation*”.

Searches were restricted to review articles to synthesize high-level evidence. Additional filters included text availability.

Study Eligibility Criteria

Inclusion Criteria:

1. Population focus: African populations (within Africa or diaspora).
2. Study type: Review articles (systematic reviews, scoping reviews, or narrative reviews).
3. Timeframe: Published within the last five years (2020–2025).
4. Content: Focus on biomedical datasets, including implications for health equity.

Exclusion Criteria:

1. Studies with no relevance to African populations.
2. Non-biomedical or non-anatomical focus.
3. Opinion pieces, editorials, or commentaries without substantial data.
4. Studies outside the specified timeframe.

Study Selection and Screening

Database filters for publication type and publication date were applied before title and abstract screening, resulting in the removal of records that did not meet eligibility criteria before screening. Study selection was conducted in a two-stage process in accordance with PRISMA 2020 guidelines: (1) title and abstract screening and (2) full-text eligibility assessment. In the first stage, titles and abstracts of all retrieved records were independently screened by two reviewers using predefined inclusion and exclusion criteria. Studies that did not focus on African populations, lacked anatomical or biomedical relevance, or were otherwise irrelevant to the review objectives were excluded. In the second stage, full-text articles were independently assessed for eligibility by both reviewers. Any disagreements between reviewers at either stage were resolved through discussion and consensus. Only studies meeting all eligibility criteria were included in the final synthesis.

Google Scholar

The initial search yielded 614 records. After filtering for review articles published in the last five years, 117 records remained.

After title and abstract screening:

1. 46 excluded (not focused on Africans)
2. 38 excluded (no anatomical/biomedical data)
3. 12 excluded (irrelevant information)
→ **21 records retained.**

After full-text assessment:

- 7 excluded (lacking sufficient anatomical/biomedical data)
→ **14 studies included from Google Scholar.**

PubMed

The search retrieved 243 records. After filtering for review articles within the last five years, 50 records remained.

After title and abstract screening:

1. 6 excluded (not focused on Africans)
2. 3 excluded (no anatomical/biomedical data)
3. 30 excluded (irrelevant population, location, or information)
→ **11 records retained.**

Final Study Pool: After combining the results of both databases, the review included a total of:

1. **14 studies from Google Scholar**
2. **11 studies from PubMed**
3. **25 studies overall**

PRISMA Flow Diagram (Consolidated Results)

Identification

Google Scholar: 614 records

PubMed: 243 records

Total records identified: **857**

After duplicates removed: **857** (since independent sources, no duplicates noted)

Screening

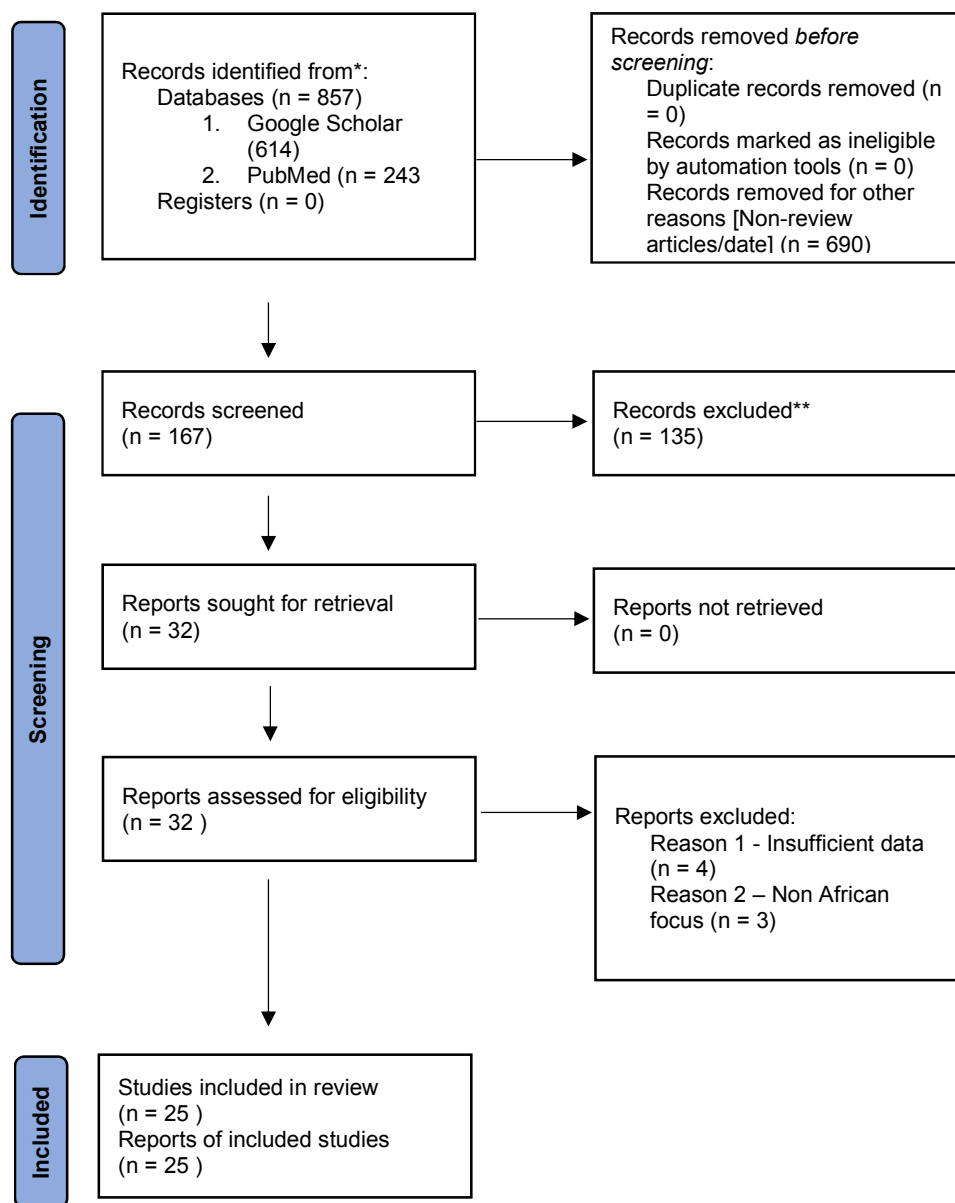
1. Records after initial filters (review articles, timeframe 5 years): **167**
 - a. Google Scholar: 117, PubMed: 50
2. Records screened by title and abstract: **167**
3. Records excluded (population irrelevance, non-biomedical focus, missing data): **135**
4. Full-text articles assessed for eligibility: **32**

Eligibility

Full-text articles excluded: **7** with insufficient anatomical/biomedical data

Included: Studies included in the final synthesis: **25**

PRISMA FLOW DIAGRAM



Quality Assessment (Risk of Bias Evaluation)

The methodological quality of included studies was assessed using a five-item checklist adapted from the Joanna Briggs Institute and AMSTAR 2 tools. The criteria evaluated clarity of objectives, methodological transparency, relevance to African populations, adequacy of evidence supporting conclusions, and discussion of limitations. Each criterion was scored as present (1) or absent (0), yielding a maximum score of 5. Studies scoring 4–5 were classified as high quality, 2–3 as moderate quality, and 0–1 as low quality. The results of this assessment

are summarized in Table 1 and were used to identify potential sources of bias and guide the interpretation of findings.

Table 1: Quality Assessment

Study	Objectives clear	Methods transparent	African relevance	Evidence supported	Limitations discussed	Total (0–5)	Quality
Amer et al., 2024	1	1	1	1	1	5	High
El Jaddaoui et al., 2020	1	1	1	1	0	4	High
Mulder et al., 2021	1	1	1	1	1	5	High
Feng et al., 2021	1	1	1	1	0	4	High
Pfennig et al., 2023	1	1	1	1	0	4	High
Sibomana, 2024	1	1	1	1	0	4	High
Ojewunmi & Fatumo, 2025	1	1	1	1	1	5	High
Oladipo et al., 2024	1	1	1	1	0	4	High
Perdomo et al., 2024	1	1	1	1	0	4	High
Croock et al., 2025	1	1	1	1	0	4	High
Moawad et al., 2023	1	1	1	0	0	3	Moderate
Delphin et al., 2024	1	1	1	1	1	5	High
Badu-Peprah et al., 2025	1	1	1	1	0	4	High
Doumatey et al., 2023	1	1	1	1	1	5	High
Fernández-Rhodes et al., 2020	1	1	1	1	0	4	High

Study	Objectives clear	Methods transparent	African relevance	Evidence supported	Limitations discussed	Total (0–5)	Quality
Laws et al., 2025	1	1	1	1	0	4	High
Thangaraj et al., 2024	1	1	1	1	0	4	High
Marconi et al., 2025	1	1	1	1	0	4	High
Reitz et al., 2023	1	1	1	1	1	5	High
Nuytemans et al., 2024	1	1	1	1	1	5	High
Ricard et al., 2023	1	1	1	1	1	5	High
Sterling et al., 2022	1	1	1	1	0	4	High
Sauer et al., 2022	1	1	1	1	1	5	High
Ndemo, 2025	1	1	1	0	0	3	Moderate
Okafor et al., 2025	1	1	1	0	0	3	Moderate

OBSERVATIONS/RESULTS

Table 2: Characteristics of included study

Author (Year)	Study type	Biomedical area	Population focus	Data focus	Key relevance to this review
Amer et al. (2024)	Systematic review	Genomics	North African	Genomic datasets	Demonstrates impact of African genomic inclusion
El Jaddaoui et al. (2020)	Narrative review	Oncology	African populations	Cancer omics data	Highlights gaps in African cancer datasets
Mulder et al. (2021)	Narrative review	Biomedical sciences	Pan-African	Research output & datasets	Documents global underrepresentation of Africans

Author (Year)	Study type	Biomedical area	Population focus	Data focus	Key relevance to this review
Feng et al. (2021)	Narrative review	Evolutionary genetics	African populations	Skin pigmentation genetics	Shows importance of African biological diversity
Pfennig et al. (2023)	Narrative review	Population genetics	African populations	Admixture & evolution	Illustrates complexity absent from global datasets
Sibomana (2024)	Narrative review	Precision medicine	African populations	Genomic diversity	Links underrepresentation to precision medicine gaps
Ojewunmi & Fatumo (2025)	Narrative review	Genomics & health equity	African populations	Genomic data equity	Advocates African-led genomic research
Oladipo et al. (2024)	Narrative review	Molecular pathology	African ancestry	Epigenetic cancer data	Highlights molecular data gaps
Perdomo et al. (2024)	Resource review	Cancer genomics	Global (limited Africa)	Biorepository data	Illustrates inequitable global cancer datasets
Croock et al. (2025)	Narrative review	Infectious disease genetics	African populations	Mitochondrial DNA	Demonstrates value of African genetic variation
Moawad et al. (2023)	Scoping review	Neuro-oncology	African populations	Research output	Shows limited African neuro-oncology data
Delphin et al. (2024)	Systematic review	Clinical trials	WHO African Region	Trial participation data	Highlights exclusion from clinical trials
Badu-Peprah et al. (2025)	Systematic review	Oncology	African populations	Survival outcomes	Shows limited outcome datasets
Doumatey et al. (2023)	Narrative review	Cardiometabolic disease	African ancestry	Gene–environment data	Demonstrates cardiometabolic data gaps
Fernández-Rhodes	Narrative review	Cardiovascular genetics	Diverse populations	Genetic association data	Highlights consequences of

Author (Year)	Study type	Biomedical area	Population focus	Data focus	Key relevance to this review
et al. (2020)					underrepresentation
Laws et al. (2025)	Systematic review	Cardiovascular disease	Global (limited Africa)	Heart failure datasets	Shows lack of diversity in CV datasets
Thangaraj et al. (2024)	Narrative review	Digital cardiology	Global	AI & digital twin data	Highlights bias risks from non-diverse data
Marconi et al. (2025)	Narrative review	Neurology	Underrepresented populations	Genetic data	Emphasizes diversity gaps in neurology
Reitz et al. (2023)	Narrative review	Neurodegeneration	Global	Alzheimer's genetics	Identifies lack of African data
Nuytemans et al. (2024)	Narrative review	Dementia research	Underrepresented populations	Biomedical research gaps	Calls for diversity-focused research
Ricard et al. (2023)	Perspective review	Neuroimaging	Global	Imaging datasets	Exposes exclusionary data practices
Sterling et al. (2022)	Systematic review	Neuroimaging	Global	Demographic reporting	Documents racial underreporting
Sauer et al. (2022)	Systematic review	Oncology trials	Global	Trial demographics	Shows race underreporting in trials
Ndemo (2025)	Systematic review	AI & health governance	African populations	Digital health data	Addresses structural data barriers
Okafor et al. (2025)	Narrative review	Interdisciplinary research	African institutions	Research capacity	Explains systemic causes of underrepresentation

The characteristics of the 25 included studies are summarized in Table 2. The studies comprised systematic, scoping, and narrative reviews spanning genomics, oncology, cardiometabolic disease, neuroscience, infectious diseases, clinical trials, and digital health. Most studies focused on African populations or highlighted the limited inclusion of African data in global biomedical datasets, underscoring the breadth and consistency of underrepresentation across biomedical domains. This review demonstrates persistent underrepresentation of African

populations in anatomical and biomedical datasets, as evidenced by the limited number of reviews directly focused on African populations, a gap that significantly limits global health equity. This lack of representation not only perpetuates scientific inequities but also creates barriers to advancing precision medicine across African populations (Ojewunmi & Fatumo, 2025).

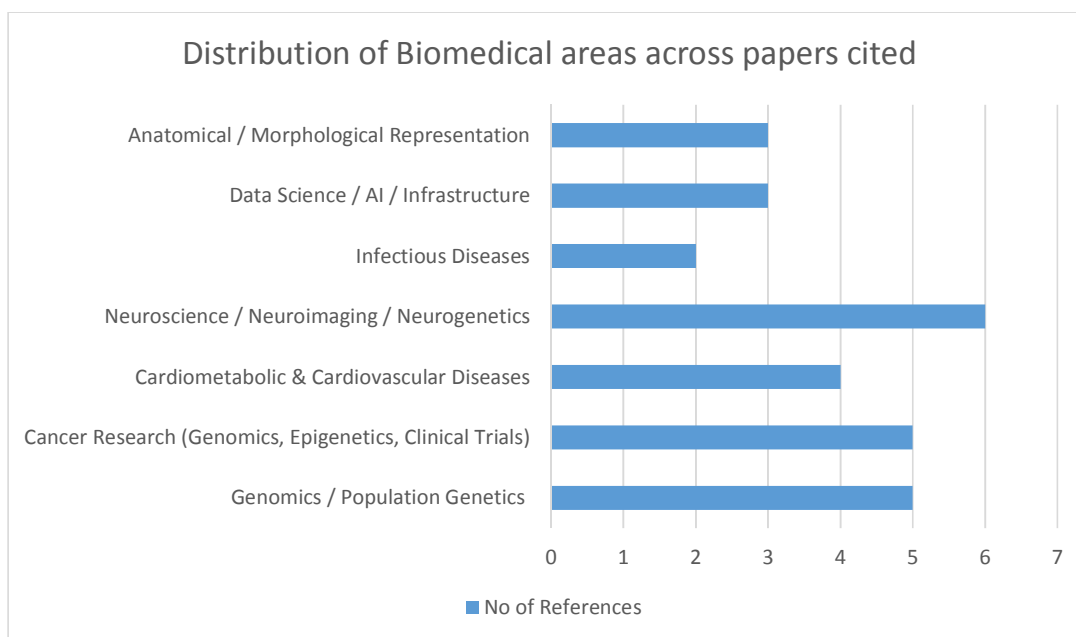
The tables below show the observations from the study

Table 3: The quantification of patterns from the study.

The frequency was calculated by categorising the papers cited in this research based on the biomedical areas they focused on and dividing it by the total papers cited multiplied by 100.

BIOMEDICAL AREAS	FREQUENCY/ PERCENTAGE	AUTHORS
Genomics / Population Genetics	~20% (5 out of 25)	Amer et al. (2024), Feng et al. (2021), Pfennig et al. (2023), Sibomana (2024), Ojewunmi & Fatumo (2025)
Cancer Research (Genomics, Epigenetics, Clinical Trials)	~20% (5 out of 25)	El Jaddaoui et al. (2020), Oladipo et al. (2024), Perdomo et al. (2024), Badu-Peprah et al. (2025), Sauer et al. (2022)
Neuroscience / Neuroimaging / Neurogenetics	~24% (6 out of 25)	Moawad et al. (2023), Marconi et al. (2025), Reitz et al. (2023), Nuytemans et al. (2024), Ricard et al. (2023), Sterling et al. (2022)
Infectious Diseases	~8% (2 out of 25)	Croock et al. (2025), Delphin et al. (2024)
Data Science / AI / Infrastructure	~12% (3 out of 25)	Mulder et al. (2021), Ndemo (2025), Okafor et al. (2025)
Anatomical / Morphological Representation	~12% (3 out of 25)	Ricard et al. (2023), Sterling et al. (2022), Okafor et al. (2025)

This table shows different biomedical areas that were discussed in the study, with Neuroscience/ Neuroimaging / Neurogenetics as the area with the highest percentage of frequency, followed by Genomics / Population Genetics and Cancer research, then Data Science / AI / Infrastructure and Anatomical / Morphological Representation, with Infectious diseases being the least.



Biomedical Areas such as Pharmacology, Basic/applied physiology, Biochemistry and drug discovery, Cell Developmental biology, Macro and Micro Anatomy, Bio signaling, Molecular Pathology were not well represented.

Table 4: Geographic distribution and biomedical focus of included studies across African regions

North Africa	Egypt, Morocco, Tunisia	Genomics, cancer research and population studies
West Africa	Ghana, Nigeria, Senegal	Cancer research, cardiometabolic disorders, and healthcare technology
East Africa	Kenya, Uganda, Ethiopia	Infectious diseases (TB hepatitis B) and genetic diversity
Southern Africa	South Africa	Tuberculosis, genomics, and population genetics

Analysis of the geographic distribution of included studies revealed that research activity was concentrated in a limited number of African countries and regions (Table 4). North African countries, particularly Egypt, Morocco, and Tunisia, were predominantly represented in genomics, cancer research, and population studies. In Central Africa, the Democratic Republic of Congo and Cameroon were mentioned in population genetic studies and genomic diversity research. (Amer et al., 2024; El Jaddaoui et al., 2020). West African representation was mainly limited to Ghana, Nigeria, and Senegal, with a focus on cancer research, cardiometabolic disorders, and healthcare technology (Doumatey et al., 2023; Fernández-Rhodes et al., 2020). East African studies were largely centered on Kenya, Uganda, and Ethiopia, primarily addressing infectious diseases such as tuberculosis and hepatitis B, as well as genetic diversity (Croock et al., 2025; Delphin et al., 2024). Southern Africa was represented almost exclusively by South Africa, with emphasis on tuberculosis, genomics, and population genetics (Moawad et al., 2023; Mulder et al., 2021).

Overall, only twelve African countries were explicitly represented across the included studies, corresponding to approximately 21% of the 56 countries on the continent (Table 2). The results indicate that achieving equity in global health requires systematic integration of African anatomical and biomedical data through regionally inclusive genomic initiatives, cross-continental collaborations, and policy frameworks that prioritize African dataset inclusion in research and clinical practice, as consistently recommended across the included studies (Amer et al., 2024; Mulder et al., 2021; Ojewunmi & Fatumo, 2025).

DISCUSSION

This review set out to critically examine the underrepresentation of African populations in anatomical and biomedical datasets, with particular attention to how this gap constrains diagnostic accuracy, surgical safety, and therapeutic outcomes. The findings confirm that African populations remain substantially underrepresented across most biomedical fields, producing knowledge gaps that have serious clinical and scientific consequences. The evidence shows that although Africa holds the greatest human genetic diversity, its people are the least represented in biomedical research, a paradox that limits the global validity of medical knowledge (Mulder et al., 2021).

Extent and Biomedical Areas of Underrepresentation

According to (Genome-Wide Association Study), In 2023, as the proportion of participants of European descent in the GWAS Catalog reached 86.5%, the representation of participants labelled “African” remained unacceptably low, at 0.47% (not including African American- or Afro-Caribbean labelled samples). (Manuel Corpas et al, 2024). Across the major biomedical domains represented in this review, the pattern of exclusion is consistent. In genomics and population genetics, most studies are still dominated by European and Asian cohorts. Even though efforts like the Egypt Genome Project are being made, there is still a large gap to fill. The implication of this void is that genetic variants that cause disease risk or drug metabolism in African populations will have a low discovery rate, making global diagnostic and therapeutic recommendations less effective (Sibomana, 2024).

Cancer research further highlights this disparity. Studies have shown that molecular pathways and the response to treatment in Africans are poorly understood due to a low existence of local genomic and epigenetic data (El Jaddaoui et al., 2020; Oladipo et al., 2024). Global oncology databases rarely include African samples, leading to limited understanding of cancers prevalent on the continent, such as breast, cervical, and liver cancers (Perdomo et al., 2024).

The gap is also evident in cardiovascular research, where diagnostic models are often trained on data from non-African populations, even though heart disease and hypertension are leading causes of mortality in Africa (Doumatey et al., 2023; Laws et al., 2025). Similarly, in neuroscience and neuroimaging, data from Africa are almost non-existent, with studies on brain structure, neurodegeneration, and cognitive function almost entirely Eurocentric (Ricard et al., 2023; Reitz et al., 2023). The lack of inclusion of African datasets reduces how accurate AI-based diagnostic tools are, thus, introducing bias into clinical interpretations (Sterling et al., 2022). Together, these findings show a clear pattern: biomedical knowledge is built upon a sample base that excludes large portions of humanity. The few inclusive projects like the Egypt

Genome Project and African neurogenetics collaborations tell how representation can improve precision medicine and research equity when properly supported (Amer et al., 2024; Ojewunmi & Fatumo, 2025).

Biomedical Areas with Little or No Representation

Beyond these well-documented fields, there are several biomedical disciplines where African representation to a lower degree. These include pharmacology, physiology, biochemistry, drug discovery, molecular pathology, and cell and developmental biology. Despite their foundational role in understanding disease mechanisms and drug responses, very few studies have explored how African anatomical or biochemical differences affect these processes.

In pharmacology and drug discovery, for example, insufficient African molecular data means that drug design and dosage recommendations are often derive from non-African models, risking reduced efficacy. Similarly, basic and applied physiology research rarely reflects population-level physiological variations, such as differences in metabolism or organ size, that could affect diagnostic ranges or treatment plans.

Biochemistry and biosignaling studies remain concentrated in Western institutions. In cell and developmental biology, more information on how cellular growth, differentiation, or tissue organization might differ across diverse genetic backgrounds is required. Even macro and microanatomy, the foundation of medical education and surgical safety, lack sufficient African datasets for digital atlases, morphometric models, and training materials. This gap directly affects clinical precision and anatomical teaching within African institutions.

Clinical and Research Implications

The clinical implications of these underrepresentations are important. Without representative data, diagnostic algorithms, drug dosing standards, and surgical procedures developed elsewhere may not safely or accurately apply to African populations. For example, inconsideration to non-African genetic differences in drug-metabolizing enzymes could lead to inappropriate medication responses (Fernández-Rhodes et al., 2020). From a research perspective, these gaps perpetuate scientific dependency and limit Africa's contribution to global knowledge. Scholars like Ndemo (2025) and Ojewunmi and Fatumo (2025) advocate for reforms in data governance and funding structures that prioritize African-led research. In addition to diagnostic accuracy, expanding participation in underrepresented fields, particularly pharmacology, physiology, and anatomical sciences, will strengthen the global scientific foundation through proper data distinction.

CONCLUSION

This review analyzed closely the reduced representation of African populations in anatomical and biomedical datasets and demonstrated how this gap restricts accuracy in diagnosis, surgical safety, and therapeutic effectiveness. The evidence indicates that the problem is not solely due to limited African research activity but largely reflects structural and policy-driven barriers, including uneven research funding, limited infrastructure, and weak integration of African-generated data into global repositories. By drawing attention to these disparities across biomedical and anatomical areas, the review underscores that unbiased representation is

fundamental to achieving precision medicine and improving patient outcomes. Policies that prioritize African-led research initiatives, mandate population diversity in global biomedical databases, and support regional data infrastructure are essential to translating African research output into clinically relevant knowledge. Conclusively, this review recommends the prioritization of African-led biomedical research, and the deliberate expansion of anatomical and biomedical datasets to reflect African population diversity.

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